



Outline

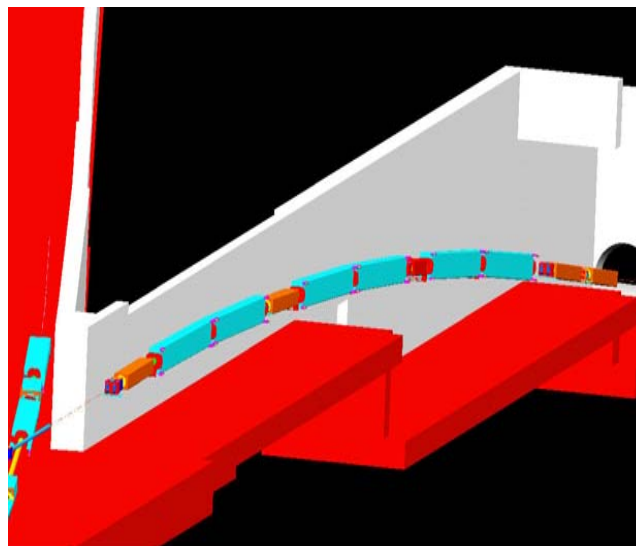
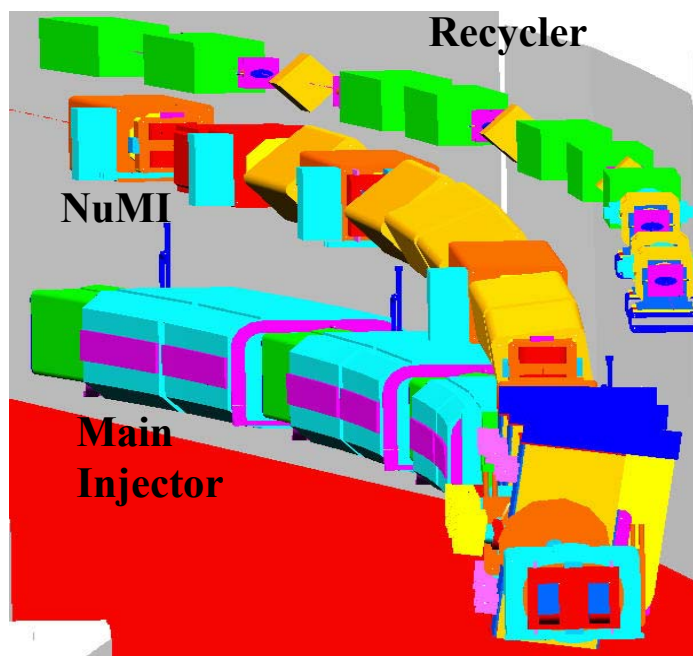
- Primary Beam Overview
- Checkout
- Organization
- Requirements for CD-4
- Commissioning Plan & Schedule
- “Early Beam” Commissioning

Scope: Describe major activities to achieve multi-batch mixed mode operation of $2.5E13$ protons/2 sec



Primary Beam

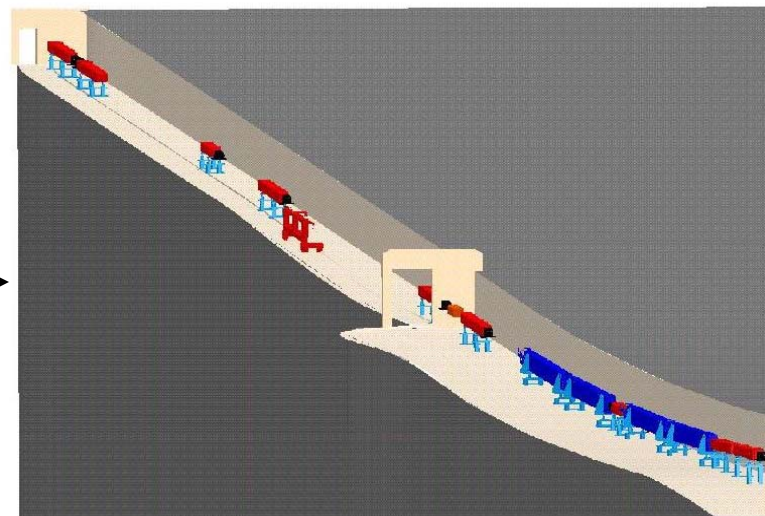
MI-60 Region



NuMI Stub

156 mrad bend

Pretarget Enclosure →
98 mrad **up**-bend &
target focus





Components

- 3 Kicker magnets and 3 Lambertsons in the MI
- 16 major bend magnets (refurbished)
- 19 MI style correctors
- 21 quadrupole magnets (refurbished)
- 10 profile monitors (UT-Austin)
 - « Low loss design - 5 micron Ti foils
- 24 beam position monitors
 - « Digital receiver electronics similar to Recycler
 - « Multi-batch position and intensity
- 2 Toroids
- 53 beam loss monitors & 4 total loss monitors
- Resistive Wall Monitor
- Optical Transition Radiation detector
 - « imaging profile monitor

New device

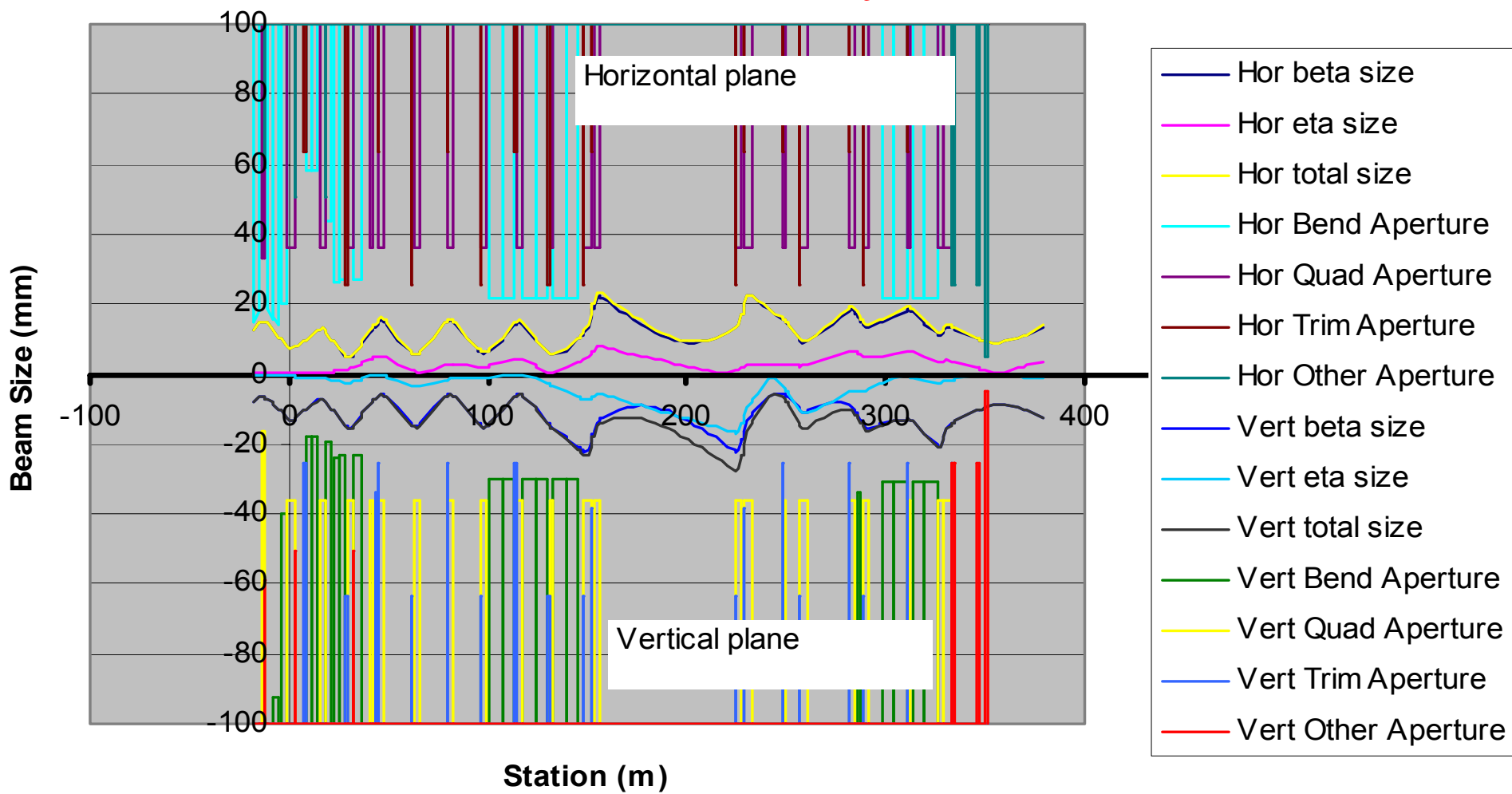
New electronics

New devices
Not in project scope

NuMI Apertures

Maximal Beam Sizes, 500pi & 3E-3, vs Clearances 09/27/02

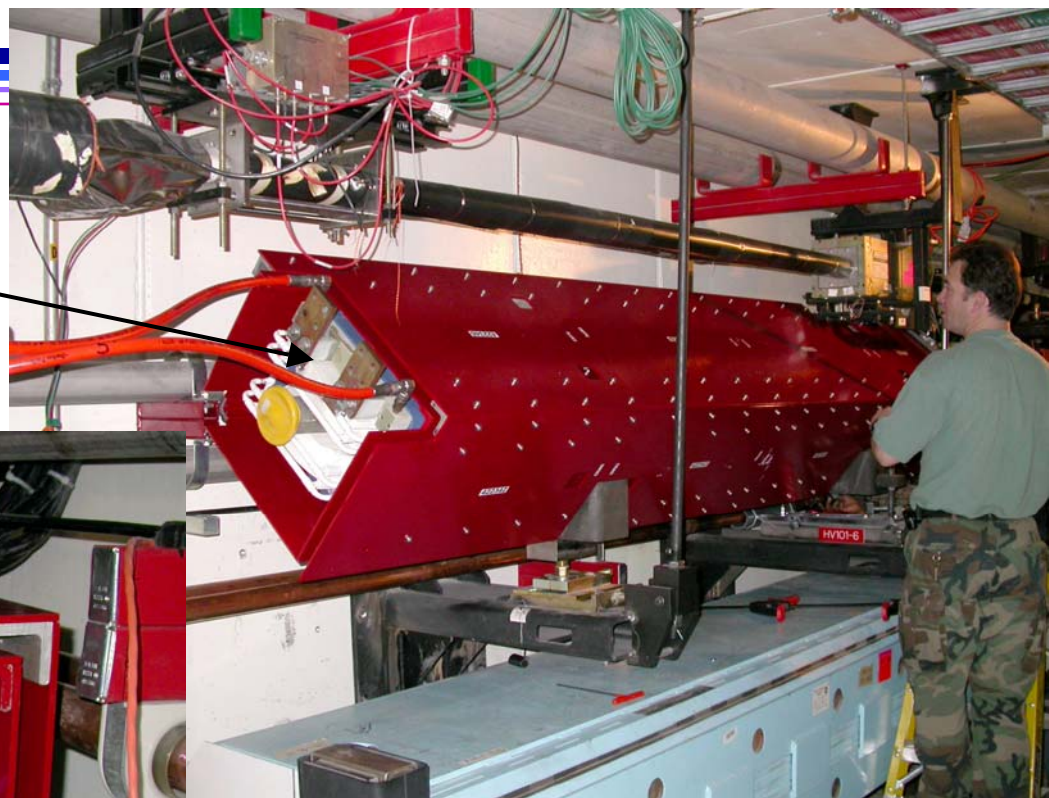
Worst Case Main Injector Beam



Shielding for the Recycler

Recycler →

NuMI Dipole



2 Gauss residual field outside
Recycler shielding - OK



Checkout

- We recognize the need to perform a methodical checkout to ensure efficient beam commissioning
- Support groups are performing the usual QC steps during checkout
- Physicists are performing additional QA on most systems
 - « Ex: Verify ACNET readout, Beam Permit System (BPS) operation during power supply tests
- We anticipate these people will participate in commissioning studies for their systems, analyze data and present results to the group



Instrumentation Checkout Assignments

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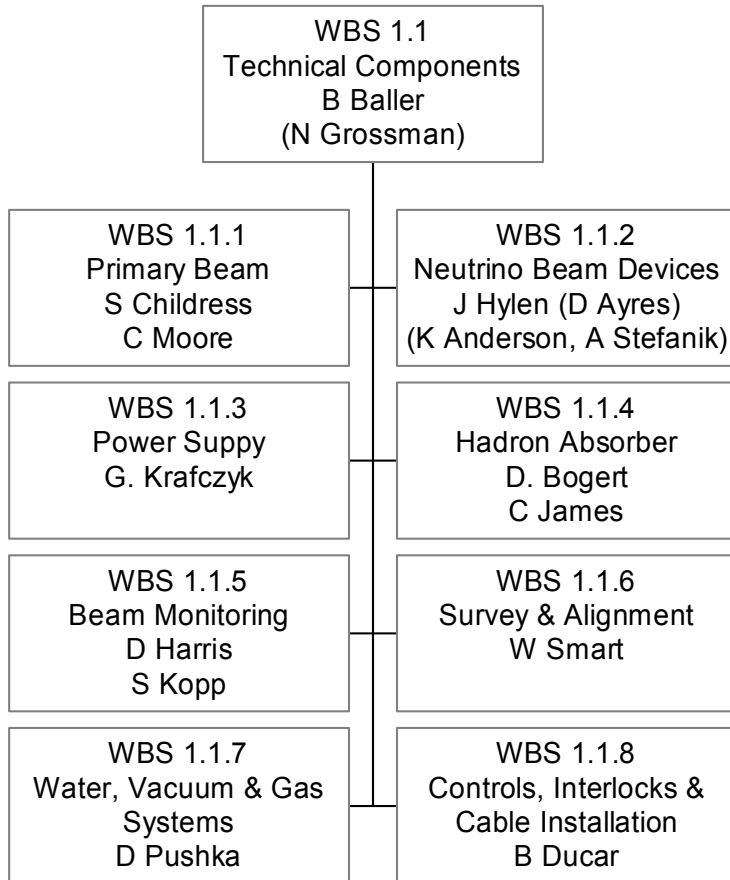
Subsystem	Hardware Expert	Software Expert	Physicist
BLM	Marv Olsen	Brian Hendricks Lin Winterowd	Gordon Koizumi
TLM	Dan Schoo	(Param. Pages) Peter Lucas	Gordon Koizumi
BPM	Peter Prieto	Brian Hendricks Lin Winterowd	Sam Childress
Profile Mon/ PM Drive	D. Schoo, Gianni Tassotto/ Al Legan	Jimmy You Junye Wang	Sacha Kopp Debbie Harris
Toroid	Brian Fellenz	(BBM) Bill Marsh	Doug Jensen
RWM	Brian Fellenz	n.a.	Doug Jensen
Instr. Timing	G. Tassotto P. Prieto		S. Childress



Checkout Status Example

Component Name	Stand	Item on	Rough	Final	Vacuum	Under	Electrical	Water	Air/Gas/	Quad	Ac N	Ac N
Walk 11/11/04 10:00AM	Installed	Stand	Aligned	Aligned	Connection	Vacuum	Connect	Connect	Fluorinert	Cool Plate	Dev	Dev
									Connect		#	ok
Kicker 1	1	1	1	1	1	1	1	1	1		11	
Loss Mon I:LMNKMA US side	1	1					1				1	
Kicker 2	1	1	1	1	1	1	1	1	1		10	
Loss Mon I:LMNKMB DS side	1	1					1				1	
Kicker 3	1	1	1	1	1	1	1	1	1		10	
Loss Mon I:LMNKMC DS side	1	1					1				1	
LAM60	1	1	1	1	1	1	1	1			1	
Loss Mon I:LML60 US bot frt	1	1					1				1	
Q608	1	1	1	1	1	1	1	1				
LAM61A	1	1	1	1	1	1	1	1			1	
Loss Mon I:LML61A US bot frt	1	1					1				1	
LAM61B	1	1	1	1	1	1	1	1			0	
Loss Mon I:LML61B US bot frt	1	1					1				1	
Gate Valve CLOSED	1	1	1	1	1	1	1		1		1	
Spool	1	1	1		1	1					0	
V100	1	1	1		1	1	1	1			1	
Loss Mon E:LMV100 US side	1	1					1				1	
Spool vertical jog; 1 IP	1	1	1		1	1	1				1	
Q101 - D	1	1	1	1	1	1	1	1			1	
Loss Mon E:LMQ101 US top	1	1					1				1	
Spool; 1 IP	1	1	1	1	1	1	1				1	
Ceramic Break	1	1	1	1	1	1					0	
BPM-V	1	1	1	1	1	1	1				14	
BPM-H	1	1	1	1	1	1	1				14	
Short Spool		1	1	1	1	1					0	
Profile Monitor	1	1	1	1	1	1	1				12	
Short Spool		1	1	1	1	1					0	
Spool	1	1	1	1	1	1					0	
Resistive Wall Monitor	1	1	1	1	1	1	1					

Technical Components Organization



NuMI Project Level 3 managers are responsible for providing an operating system:

Includes design, fabrication, installation, checkout and commissioning

The commissioning coordinator (Technical Components Manager) is responsible for defining the overall commissioning plan & monitoring progress



CD-4 Goals

The NuMI Project Management Plan describes the Technical Commissioning Goals required to meet CD-4

Goal	Parameter	Measurement	Commissioning Goal
1	Proton intensity in target hall	Toroid (or equivalent) beam intensity at entrance to the Target Hall	Greater than 1E12 120 GeV protons/spill
2	Beam alignment	Transverse distributions of the proton beam and secondary beams	Proton direction established to within 1 mr of the known direction to the Far Detector in the Soudan mine.
3	Neutrino beam energy	Near detector event energy	Low energy, 2-4 GeV
4	Cosmic ray muons detected in the MINOS near detector	Near detector data read out through DAQ system	Majority of 153 near detector planes sensitive to muons
5	Near detector neutrino flux	Charged current event rate in 1.5 ton fiducial region	Observer neutrinos in the near detector produced by the NuMI beam
6	Cosmic ray muons and atmospheric neutrinos detected in each of the two MINOS far detector super-modules	Far detector data read out through DAQ system	Majority of the 484 planes of the far detector sensitive to muons and atmospheric neutrinos



Commissioning Plan

- NuMI checkout & commissioning activities are tracked using MS Project and Excel
- Pre-commissioning activities
 - « Main Injector Preparations (~65 tasks)
 - « NuMI checkout (200 - 700 tasks)
 - « Administrative Approvals (~15 tasks)
 - « Operations Preparations (~20 tasks)
- Commissioning
 - « MI/NuMI commissioning (~60 tasks)
 - « Multi-batch mixed-mode (2 tasks)
 - « Turnover to Operations (2 tasks)
- Plan developed in April workshop
 - « Reviewed by DOE and AD management



Administrative Approvals

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- The Main Injector Shielding Assessment was revised to allow operation at 4.8×10^{13} protons 2 second cycle
 - « Adequate to support NuMI operations for the next several years
- The NuMI Shielding Assessment was approved
- DOE FSO and ARR team has informally reviewed the MI and NuMI Safety Assessment Documents (and Safety Envelopes)
 - « Comment resolution complete
- SAD's were approved by the Director and formally transmitted to FSO last week
 - « Concurrence expected in the next few weeks



Operations Preparations

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- Controls needs
 - « Add NuMI devices to the ACNET database
 - « Develop parameter pages
 - « Set up BPS and alarms & limits pages, sequencers
 - « Define device list for data-logging
 - « Set up data logger
 - « Set up Beam Loss Budget Monitor and Beam Budget Monitor
- Administration & Training
 - « Develop Search & Secure procedures & training
 - « Develop emergency response procedures & training
 - « Define access requirements, threshold criteria for NuMI operation
 - « Develop and conduct operator training, Rookie book
 - « Define list of qualified experts

Step	Description	Purpose	Special Req'mnts	Proton Intensity (ppp)	Cycle Time (sec)	Profile Mon	Tgt Pos	Horn Status	ND neutrinos/hr/100T	Approx Dur (days)	Day	CD-4 Goal
1	Main Injector setup	NuMI single batch setup. Ramp timing, Autotune validation	NuMI enabled. Kicker off. 2 turns 30 bunches	3.E+11	180	In	Out	Off	0	0.5	0.5	
2	First beam to NuMI	Beam tuning to observe beam profiles	No below ground access	3.E+11	180	In	Out	Off	0	1	1.5	
3	Aperture Scan	Check transport apertures & transport matrix		3.E+11	180	In	Out	Off	0	1	2.5	
4	Horn Alignment	Check horn alignment with beam scan & tgt pit LM		3.E+11	180	In	Out	Off	0	0.5	7.5	
5	Target/Baffle Alignment - LE	Check target/baffle alignment with beam scan & tgt pit LM		3.E+11	180	In	LE	Off	0	0.5	8.5	
6	Raise intensity	Observe hadron monitor beam profile. Check magnet ramp timing		1.E+12	180	In	Out	Off	0	1	3.5	1,2
7	Calibration & first neutrinos	Calibrate loss monitors & BPM's. Check horn timing with pit loss monitor?		1.E+12	60	In/Out	ME	On	8	1	4.5	3,5
8	BPS tuning	Tighten BPS inputs		1.E+12	60	Out	ME	On	0	1	5.5	
9	Rad Surveys	Check dose rates in occupied areas	BPS trip on high intensity/loss -> STD XPRT	1.E+12	180	Out	ME	On	3	0.5	6	
10	Monitor position sensitivity	Check BPM, profile monitor, target, baffle, mu mon & had monitor sensitivity	BPS STD XPRT	1.E+12	180	In	ME	Off	0	1	7	
11	Target/Baffle Alignment - ME	Check target/baffle alignment with beam scan & tgt pit LM	BPS STD XPRT	3.E+11	180	In	ME	Off	0	0.5	8	
12	BPS tuning	Add tgt/baffle/horn inputs to BPS. Define "baseline running conditions"	BPS STD	1.E+12	180	Out	LE	On	2	0.5	9	
13	Multi-batch tuning	Establish Main Injector multi-batch operation. Check NuMI transport & optics	BPS STD	5.E+12	180	Out	LE	On	9	5	14	
14	Reduce cycle time	Establish standard NuMI cycle time	BPS STD	5.E+12	2	Out	LE	On	783	5	19	

Schedule

- Expected status in early December
 - « The MI-60 region will be ready at the end of the shutdown
 - « The Pre-Target area should be ready but alignment is a concern
 - « The absorber cooling system may be checked out
 - * not needed for low intensity operations
 - « The hadron and muon monitoring systems will be ready
 - « The Target Hall will not be ready until mid January
 - * Radioactive component handling practice & target chase cooling system
- Planning for low intensity beam to the NuMI absorber on December 3 - 4 and December 10 – 12 “Early Beam”
 - « Allows problem identification and resolution before the accelerator complex returns to normal operation
 - « First 3 steps in overall commissioning plan



Early Beam Plan

- Goals
 - « Extract 120 GeV protons (single batch) from the MI and transport to the NuMI absorber (1st weekend)
 - « Time-in instrumentation and verify function (1st weekend)
 - « Verify kicker uniformity (2nd weekend)
 - « Check transport optics (2nd weekend)
- Constraints
 - « Prevent undue activation of the Target Hall pit that could delay work
 - « MARS simulation shows minimal activation with $< 1\text{E}14$ protons and 48 hour cool-down
- We will commission using $3\text{E}11$ protons every ~ 3 minutes



Early Beam Schedule

- Start NuMI study cycle on Dec 2 (Thur)
 - « Ramp NuMI magnets
 - « Verify Beam Permit System operation
- NuMI beam
 - « Friday Dec 3, 0900-2100
 - « Saturday Dec 4, 0900 – 2100
- Commissioning team from MI, NuMI, Ext. Beams, CERN

Team 1

Peter Lucas

Malika Meddahi (CERN)

Gordon Koizumi

Sam Childress, Ldr.

Alberto Marchionni

Team 2

Doug Jensen

Al Russell

Rick Ford

Craig Moore, Ldr.

Dave Capista



Next Steps

-
- Commissioning will resume in mid January when the Target Hall is complete
 - We expect to meet CD-4 in late January
 - Physics data taking begins in February



Closing Comments

- This is an exciting time for NuMI and MINOS
 - « Culmination of 10 years of planning
 - « 40+ internal reviews, 14 Director's reviews, 14 DOE reviews
- NuMI is a visible project within the HEP community and DOE
 - « We are planning for an efficient startup